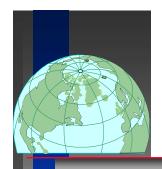
Engineered Fuels for a Cleaner Environment: E-Diesel & P-Series Alternative Fuels

Irshad Ahmed
Pure Energy Corporation
One World Trade Center, New York

7th National Clean Cities Conference and Expo Pennsylvania Convention Center Philadelphia, Pennsylvania May 13-16, 2001



Pure Energy Corporation (PEC)



- Privately funded corporation established in 1992
- Developer of alternative transportation fuels and chemicals from renewable resources
- Technical staff of over 40 internal and external experts
- Patents on unique fuel formulations, additives and bioprocess technologies
- Global business plan





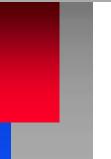
Engineered Fuels Concept

Challenge: Sustain global standard of living while managing energy supply, human health and the environment

- Stretch fossil energy supply sources
- Manage global environmental impact
- Utilize existing supply infrastructure
- Minimize economic impact of change
- Integrate food and energy production
- Fuels and chemicals production synergy
- Maximize carbon source utilization efficiency
- Balance regulatory and public policy initiatives with technical and commercial advancement
- Educate policy makers, public and private businesses to participate in a global change for a sustainable future



Ethanol





Pure Energy's Product Platforms

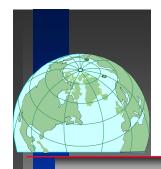
Engineered Fuel Formulations

- Oxygenated Ethanol-Diesel Blends (Oxydiesel)
- P-Series Alternative Fuel (US EPACT Designated)
- D-Series Formula for Unmodified Gasoline Engines
- Ethanol-Gasoline RVP Modulator and Blending Agent

Biorefinery Technology

- Biomass Ethanol
- Chemicals
 - Furfural chemicals
 - Levulinic acid (carboxylic acid chemistry)
 - ◆ Ketone-diol chemistry



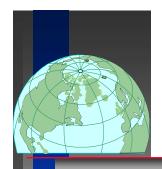


Technical Partnerships



- SUNOCO (SUN Oil)
- Southwest Research Institute (SwRI)
- TRW Laboratories & Phillips Petroleum
- Intertek Testing Caleb-Brett Laboratories
- Saybolt Laboratories and Compliance Research Labs
- Automotive Testing and Paragon Research Labs
- EA Engineering, Science, and Technology, Inc.
- University of Illinois and Princeton University
- Oak Ridge and Argonne National Laboratories
- Raytheon Engineers and Constructors
- Tennessee Valley Authority (US National Lab)

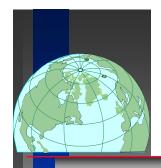




Diesel Markets Conditions

- United States consumes over 50 billion gallons of No. 1 and No. 2 diesel annually
 - ◆ On-Highway consumption accounted for 60%
 - ◆ Centrally refueled fleets use over 5 billion gallon
 - ♦ No. 1 diesel accounts for about 3 billion gallon
 - ◆ Diesel vehicles on US roads account for 3% of all vehicles but 25% of all pollution
- World diesel markets in 1999 was 200 billion gallon
 - ♦ European consumption exceeds 50 billion gallon
 - Higher diesel use in light-duty vehicles in Europe
 - Global diesel markets are growing faster then gasoline markets





Regulatory Challenges

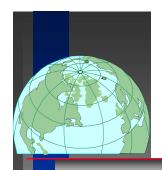
Proposed United States EPA rules for diesel fuel

- Reduce sulfur from current 500 to 15 ppm in 2007
- Reduce PM to 0.1 in 2002 and 0.01 g/bhp-hr in 2007
- NOx reduction to 2.0 g/bhp-hr in 2002 and lower in 2007

Regulatory implementation challenges

- NOx traps are fouled at above 3 ppm sulfur level
- Supply limitation based on production and distribution
 - Hydrodesulfurization (HDS) capacity limitation
 - ♦ US \$10 billion estimated cost to upgrade refineries
 - Pipeline segregation between ULSD and reg. diesel





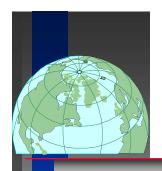
Sulfur Characterization in Diesel (Technical Challenges)

Typical sulfur compounds targeted by next generation (and expensive) hydrodesulfurization process in diesel



- Sulfur in diesel is present in complex matrix
- Sulfur-based compounds are key property providers
- One-third of all diesel processed in US is Light Cycle
 Oil (LCO) which is tough to process for sulfur
- High cost hydrocracking vs. low cost hydrotreating





Regulatory Challenges

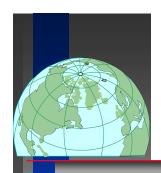
"Chaos Scenario" (2007 EPA Regulations)

"US diesel marketers, end-users, and some officials fear that a big chunk of the diesel production capacity will exit the highway fuel market in 2007, causing fuel prices to skyrocket, triggering an economic chaos"

- Under best scenario the US refinery can only produce 200,000 bpd of ULSD meeting only 8% of the demand
- Industry estimates a \$0.13 to \$0.15 per gallon additional ULSD cost based on current refinery production scheme
- Distribution cost for ULSD will add an additional \$0.07 to \$0.10 per gallon

Source: EPA Proposes 15 ppm Diesel Sulfur Rule, World Refining, June 2000; and Turner, Mason, Houston, Texas, 1999.





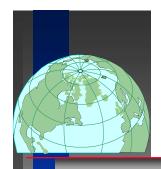
Pure Energy's Oxydiesel with PuranolTM Additive System



- Available in commercial quantities today
- Excellent compatibility with existing fuel distribution infrastructure and requires no engine modifications
- Minimal to no cost penalty

If ethanol-diesel blends capture only 5-percent of the global diesel market, it will account for ~1.0 billion gallons of ethanol produced from 10 million metric tons of biomass or about 400 million bushels of corn or other grain crop annually





Pure Energy's Oxydiesel



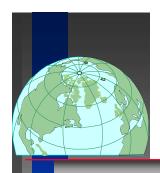
- Splash blend of 5-15% ethanol, Puranol and diesel
- Unmodified compression ignition engines
- Utilizes existing distribution infrastructure
- Excellent cold temperature and water resistance
- Engine and fuel injector wear reduction
- Upgrades #2 diesel to #1 performance
- EPA registered fuel formulation and additive

Oxydiesel Cost Differential

Annual gallon compared to No. 2 Diesel = \$0.05 to \$0.07

Annual gallon compared to No. 1 Diesel = -\$0.05 to \$0.00





Pure Energy's Puranol Additive System

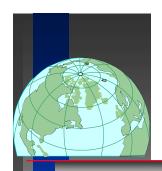


- Clear solution stable to -40°C in the presence of water
- Contains only Carbon, Hydrogen, and Oxygen
- No metals or metal containing compounds
- Made from commercially available components
- Excellent pour point, lubricity, and cetane
- Stable against microbial attack for long-term storage
- Conformity with ASTM protocols

US Patents Issued Related to Additive System

Pure Energy has received five US and over 15 international patents on its E-Diesel and P-Series fuel formulations to date





Oxydiesel Emissions Profile (Heavy Duty Diesel Engine)

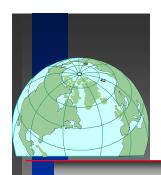
A 15-percent ethanol with No. 2 diesel has been tested in three HD demonstration projects in over <u>one million miles</u>



- Particulate Matter (PM) is reduced by 41-percent
- Oxides of Nitrogen (NOx) is reduced by 5-percent
- Carbon monoxide (CO) is reduced by 27-percent
- Sulfur reduction in ethanol blend of 20-percent
- Neutral emissions of Total Hydrocarbons (THC)

Note: Tests done at Southwest Research Institute, San Antonio, Texas, 1999.





Oxydiesel Emissions Profile (Light Duty Diesel Engine)

Emissions profile of oxydiesel in a 1.9-liter TDI Volkswagen industrial diesel engine with direct fuel injection plus EGR

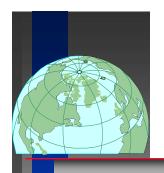
Engine map or operational regions with simultaneous PM and NOx reduction are identified

Oxydiesel Composition	Engine Speed (rpm)	Engine Load (percent full)
10% Ethanol	1500	50% - 100% (~105 Nm)
15% Ethanol	1700	50% - 60% (>105 Nm)

PM Reduction Range = 22-75% (within the above map NOx Reduction Range = 60-84% and variable ethanol)

Note: Tests done at Argonne National Laboratories, Argonne, Illinois, and AutoResearch Laboratories, Chicago, Illinois, and August 2000.

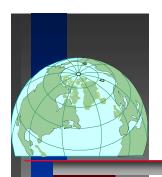




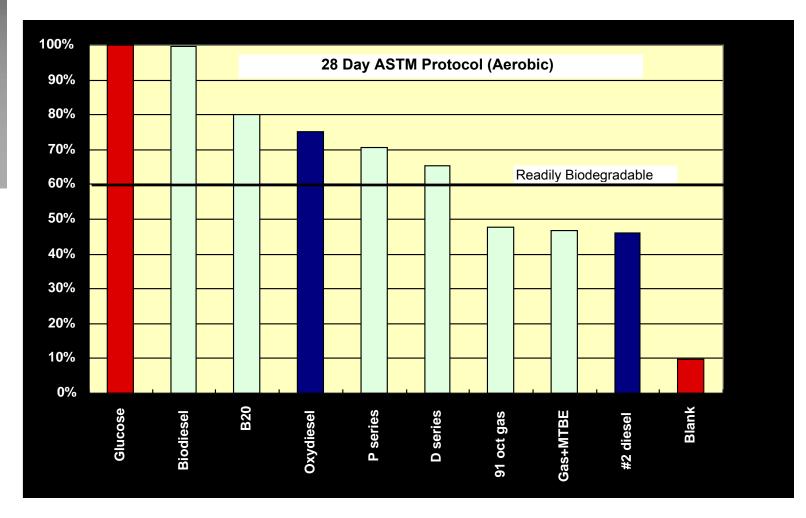
Oxydiesel Fuel Properties

Property	Test Method	No. 2 Diesel	E15 Diesel
Water & Sediment, % max	ASTM D1796	0.05	0
Distillation % vol rec. T-90 (°C)	ASTM D 86	332	311
Kinematic Viscosity, 40°C (cSt)	ASTM D445	1.9-4.1	2.25
Ash (%) max	ASTM D482	0.01	0.001
Sulfur (%) max	ASTM D2622	0.05	0.04
Copper Corrosion @ 3 hr max	ASTM D130	3b	1a
Cetane Number, min	ASTM D613	40	45
Cetane Index, min	ASTM D4737	45	42
Rams. Carbon, 10% res.	ASTM D4530	0.35	0.22
API Gravity, max	ASTM D287	39	38
Lubricity (g) min	ASTM D6078*	3100	5200
Accel. Stability, pass/fail test	Octel F-21	Pass	Pass
Cloud Point (°C)	D2500	-15	-5
LTFT at -11°C, pass/fail test	D4539	Pass	Pass
LTFT at -19°C, pass/fail test	D4539	Fail	Pass

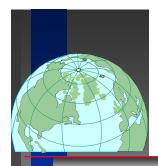




Biodegradability







Fuel Demonstration Partnerships

Fleets

- Archer Daniels Midland Company
- Chicago Transit Authority
- Waste Management Inc.
- City of Philadelphia (P-Series)

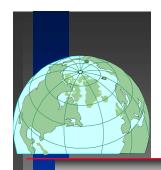
Fuel Distributors

- SUNOCO (P-Series)
- Growmark, Inc. (E-Diesel)

Other Partners

- Detroit Diesel, Cummins, Mack, and Caterpillar
- Chem Central
- US Department of Energy
- Southwest Research Institute
- Illinois Dept. of Commerce and Community Affairs
- Illinois Corn Growers Association



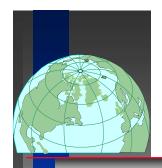


Archer Daniels Midland (ADM) Demonstration Program Results



- Completed over 400,000 miles on four Mack Trucks
- Two years of successful operation
- Compatibility in unmodified Mack engine
 - ♦ No change in fuel filter deposits
- Excellent cold start performance (–21°F)
- Minimal power loss under full load
- Better than theoretical fuel economy on #2 diesel
 - → -5% average (5.7 vs. 6.0 mpg)
- Compatibility with distribution infrastructure
- Batch splash blending at 5,000 gallons



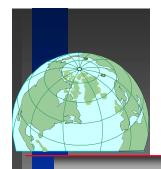


Chicago Transit Authority Demonstration Results



- Completed 500,000 miles in 30 city buses
- Successful nine months of one year program
- Compatibility in unmodified engines
 - Detroit Diesel and Cummins
 - No change in fuel filter deposits
- Compatibility with distribution/storage infrastructure
 - Water contamination management
- Equivalent fuel economy
 - ♦ 3.25 mpg
- Batch splash blending at 15,000 gallons





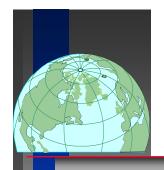
P-Series Fuel Performance

Fuel Blend: 32% Pentanes Plus + 50% Ethanol + 18% MTHF

Fuel Property (units)	UTG-96	RFG II	COMS	E-85	P-Series
Octane (R+M/2)	91.9	91.7	89.6	96.0	90.2-93.8
Energy (Btu/gal)	114,500	111,800	115,200	83,500	~104,000
RVP (psi)	9.2	8.4	7.4	6.9	7.2-7.8
Sulfur (ppm)	100	290	330	8	< 9
Benzene (ppm)	0.78	1.28	1.98	0.32	0.21-0.27
Oxygen (wt%)	0	2	0	28	18-23
Hydrogen (wt%)	12.4	13.7	13.2	12.0	13.1-13.4
Aromatics (vol%)	30.2	24.2	36.8	3.6	0.5-0.8
Renewables (vol%)	0	~10	0	83.6	55-68

NOTE: Tests performed at Automotive Testing Laboratories, Columbus, Ohio, and other independent laboratories between 1996 and 1999





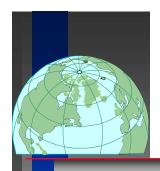
P-Series Fuel Emissions

Fuel Blend: 32% Pentanes Plus + 50% Ethanol + 18% MTHF

Emission Component (grams per mile)	UTG-96	RFG II	COMS	E-85	P-Series
NM Hydrocarbon	0.14	0.11	0.14	0.12	0.07
NM Organic Gas	0.15	0.13	0.16	0.21	0.08
Carbon Monoxide	1.40	1.20	1.40	1.20	1.00
Carbon Dioxide	422	417	422	397	407
Ozone Potential	0.48	0.46	0.52	0.48	0.30
Miles Per Gallon	21	20	21	15	19

NOTE: Tests performed on two Ford Taurus E-85 (1996 and 1997 model years) at Automotive Testing Laboratories, Columbus, Ohio, 1996 to 1998



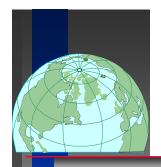


City of Philadelphia P-Series FFVs Demonstration Program



- One year successful demonstration program
- SUNOCO supplied the fuel under agreement with PEC
- Engine oil degradation and emissions profile were assessed during the program and found satisfactory
- **■** Potential expansion of the program with other partners
 - United States Postal Service (USPS) fleet in Greater Philadelphia area
 - General Administrative Services (GSA)
- Clean Cities Coalition and US DOE participation
- Material compatibility and durability testing
 - DuPont & other Ford approved suppliers are working with PEC to evaluate elastomers compatibility





Conclusion



- Performance and compatibility validated in one million miles on the road in FFVs, busses and trucks
- E-Diesel is available today for full fleet conversion
- Attractive full-cost economics
- Existing distribution logistics
- Strong end-user demand both in US and abroad
- Strong regulatory and public policy drivers

Pure Energy's commercialization approach is based on real-time problem solving and customer fleet operation protection

